CLAIMS

1. A test system able to assess photometric performance characteristics of an endoscope comprising:

a photometric measurement module comprising a measurement integrating sphere and at least one adapter able to optically connect the integrating sphere to a plurality of different optical ports of different endoscopes, wherein the photometric measurement module measures data from at least one photometric characteristics selected from the group consisting of absolute optical intensity, relative optical intensity, optical power, optical energy, illuminance, radiance, irradiance, display color, perceived color and transmittance; and,

a controller containing computer-implemented programming that controls at least one of the calibration, measurement and analysis of the photometric performance characteristics of an endoscope using the data from the photometric measurement module.

2. The test system of claim 1 wherein the data are measured over a plurality of discrete wavelengths or wavelength regions.

3. The test system of claim 1 wherein the system further comprises an image quality measurement module comprising at least one adapter able to optically connect the image quality measurement module to a plurality of different endoscopes, wherein the image quality measurement module measures data from at least one image quality performance characteristic selected from the group consisting of image size, spatial distortion, contrast, brightness, image resolution, focus and modulation transfer function, and the controller contains computer-implemented programming that controls at least one of the calibration, measurement and analysis of the image quality performance characteristics of an endoscope using the data from the image quality measurement module.

4. The test system of any one of claims 1 to 3 wherein the system further comprises a structural element measurement module comprising at least one adapter able to operably connect the structural element measurement module to a plurality of different endoscopes, wherein the structural element measurement module measures data of structural element performance characteristic selected from at least one of a mechanical, a pneumatic and a fluidic system of an endoscope, and the controller contains computer-implemented programming that controls at least one of the calibration, measurement and analysis of the structural element performance characteristics using the data from the structural element measurement module.

5. The test system of claim 1 wherein the controller further controls data acquisition by the photometric measurement module, the image quality measurement module and the structural element measurement module.

6. The test system of claim 1 wherein the controller contains computer-implemented programming that tracks performance trends over time of at least one of the photometric characteristics, image quality characteristics and structural element characteristics.

7. The test system of claim 1 wherein the computer-implemented programming additionally responds to a set of operator input instructions to control the data acquisition and analyses of the photometric measurement module, the image quality measurement module and the structural element measurement module.

8. The test system of claim 1 wherein the computer-implemented programming additionally provides for calibration of a response of at least one of the photometric measurement module, the image quality measurement module and the structural element measurement module the measurement module using a reference standard to provide calibration correction factors, and application of the calibration correction factors to the data collected by the photometric

measurement module, the image quality measurement module or the structural element measurement module provide a corrected data set.

9. The test system of claim 1 wherein the computer-implemented programming additionally provides for acquisition and storage of a background signal data set; acquisition and storage of a measurement signal data set representing raw data obtained from the sample device; and, subtraction of the background signal data set from the measurement signal data set to generate a background corrected measurement data set.

10. The test system of claim 9 wherein the computer-implemented programming additionally applies the calibration correction factors to the background corrected measurement data set to generate a calibrated measurement data set.

11. The test system of claim 10 wherein the computer-implemented programming additionally:

analyzes the background corrected measurement data set to determine if the background corrected measurement data set is of acceptable quality to provide an acceptable background measurement data set and provides an indicator to the operator if the background corrected measurement data set is not of acceptable quality; and

analyzes the background corrected measurement data set with the calibration measurement data set and provides an indication of a performance characteristic for at least one of the photometric characteristics, the image quality characteristics and the structural element characteristics based on the background corrected measurement data set with the calibration measurement data set.

12. The test system of claim 11 wherein the computer-implemented programming additionally determines whether the performance characteristic is within an acceptable range.

13. The test system of claim 11 wherein the computer-implemented programming determines the performance characteristic for each of the photometric characteristics, the image quality characteristics and the structural element characteristics.

14. The test system of claim 12 or 13 wherein the computer-implemented programming additionally records the performance characteristic in a computer-readable memory to provide a recorded measurement data set.

15. The test system of claim 14 wherein the computer-implemented programming additionally compares and analyzes at least one performance characteristic from a recorded measurement data set and at least one additional performance characteristic from a different time for at least one temporal trend.

16. The test system of claim 15 wherein the computer-implemented programming additionally provides an indicator of the temporal trend.

17. The test system of claim 1 wherein the computer-implemented programming additionally analyzes the data obtained from the photometric measurement module, the image quality measurement module and the structural element measurement module to determine if the data comprises an acceptable signal level and if not then adjusts data acquisition until the acceptable signal level is obtained.

18. The test system of claim 17 wherein the computer-implemented programming further provides an indicator to the operator if the acceptable signal level is not obtained.

19. The test system of claim 4 wherein the structural element measurement module

comprises a pressure transducer and a flow meter, and the adapter operably connects the structural element measurement module to an endoscope to transfer a gas, a liquid or a vacuum between the structural element measurement module and the endoscope.

20. The test system of claim 1 wherein the photometric measurement module comprises a spectrometer comprising a wavelength dispersive element optically connected to the measurement integrating sphere.

21. The test system of claim 1 wherein the at least one adapter comprises a set of removable adapters able to optically connect to a plurality of light-emitting ports of a plurality of different endoscopes.

22. The test system of claim 21 wherein the removable adapters comprise a flexible fiber optic or a liquid light guide.

23. The test system of claim 1 wherein the system further comprises an illumination light source having a known spectral distribution and an illumination integrating sphere optically connected to the illumination light source.

24. The test system of claim 23 wherein the illumination integrating sphere is optically coupled to the illumination light source by at least one of a flexible fiber optic, a liquid light guide, a condenser lens assembly, a mirror or a prism.

25. The test system of claim 21 wherein a mating surface of the removable adapters that mates with an interior surface of the illumination integrating sphere or the measurement integrating sphere comprises a curvature that substantially matches the curvature of the interior surface, such that the mating surface lies substantially flush with the interior surface.

26. The test system of claim 25 wherein at least one removable adapter comprises a first mating surface sized to fit the first integrating sphere and a second mating surface sized to fit the second integrating sphere.

27. The test system of claim 3 wherein the image quality measurement module comprises a linearly arrayed sensing element.

28. The test system of claim 27 wherein the linearly arrayed sensing element is selected from the group consisting of a line scan CCD detector and a linear diode array.

29. The test system of claim 28 wherein the linearly arrayed sensing element can be translated or rotated relative to a conjugate image plane of the endoscope to make at least one measurement in the conjugate image plane.

30. The test system of claim 28 wherein a conjugate image plane of the endoscope can be translated or rotated relative to the linearly arrayed sensing element to make one or more measurements in the conjugate image plane.

31. The test system of claim 29 or 30 wherein the computer-implemented programming can reconstruct a sequence measurements of in the conjugate image plane to create a two-dimensional digital image of the conjugate image plane.

32. A photometric measurement system comprising an integrating sphere optically connected to a receive light from a measurement probe sized that is shaped to receive light from an image display screen, the integrating sphere further optically connected to transmit light to a photometric measurement device comprising a spectrometer comprising a wavelength dispersive

element, wherein the photometric measurement system is operably connected to a controller containing computer-implemented programming that responds to a set of operator input instructions to control the data acquisition and analyses of the photometric measurement system and that controls measurement of the image display screen.

33. The photometric measurement system of claim 32 wherein the image display screen is operably connectable to an endoscope to display an image transmitted from the endoscope.

34. The photometric measurement system of claim 32 or 33 wherein the image display screen is operably connectable to a signal generator able to generate a plurality of test signals on the image display screen.

35. The photometric measurement system of claim 34 wherein the computer-implemented programming additionally provides for calibration of a response of the photometric measurement module using a reference standard to provide calibration correction factors, and application of the calibration correction factors to the data collected by the photometric measurement module to provide a corrected data set.

36. The photometric measurement system of claim 35 wherein the computer-implemented programming additionally provides for acquisition and storage of at least one of a dark spectrum signal data and a background signal data set; acquisition and storage of a measurement signal data set; and, subtraction of the background signal data set from the measurement signal data set to generate a background corrected measurement data set.

37. The photometric measurement system of claim 36 wherein the computer-implemented programming additionally applies the calibration correction factors to the

background corrected measurement data set to generate a calibrated measurement data set.

38. The photometric measurement system of claim 37 wherein the computer-implemented programming additionally:

analyzes the calibrated measurement data set to determine if the calibrated measurement data set is of acceptable quality to provide an acceptable calibrated measurement data set and provides an indicator to the operator if the calibrated measurement data set is not of acceptable quality;

analyzes the acceptable calibrated measurement data set and provides an indication to a user of a performance characteristic for the photometric characteristics.

39. The photometric measurement system of claim 38 wherein the computer-implemented programming additionally determines whether the performance characteristic is within an acceptable range.

40. The photometric measurement system of claim 39 wherein the computer-implemented programming additionally records the performance characteristic in a computer-readable memory to provide a recorded measurement data set.

41. The photometric measurement system of claim 40 wherein the computer-implemented programming additionally compares and analyzes at least one performance characteristic from a recorded measurement data set and at least one additional performance characteristic from a different time for at least one temporal trend.

42. The photometric measurement system of claim 41 wherein the computer-implemented programming additionally provides an indicator of the temporal trend.

43. The photometric measurement system of claim 33 wherein the computer-implemented programming additionally analyzes the data obtained from the photometric measurement module to determine if the data comprises an acceptable signal level and if not then adjusts data acquisition until the acceptable signal level is obtained.

44 The photometric measurement system of claim 43 wherein the computer-implemented programming further provides an indicator to the operator if the acceptable signal level is not obtained.

45. A photometric system to assess optical characteristics of a light source, the system comprising:

photometric measurement module comprising a measurement integrating sphere and at least one light collector sized and shaped to transmit substantially all wavelengths of UV, visible and NIR light from the sample light source to the integrating sphere, the measurement integrating sphere optically connected to transmit substantially all wavelengths of UV, visible and NIR light from the measurement integrating sphere to a photometric measurement device that is able to measure substantially all wavelengths of UV, visible and NIR light, wherein the photometric measurement module is operably connected to a controller containing computer-implemented programming that responds to a set of operator input instructions to control the data acquisition and analyses of the photometric measurement module and that controls measurement and analysis of the sample light source.

46. The photometric system of claim 45 wherein the computer-implemented programming additionally provides for calibration of a response of the photometric measurement module using a reference standard to provide calibration correction factors, and application of the calibration correction factors to the data collected by the photometric measurement module to provide a corrected data set.

47. The photometric system of claim 45 or 46 wherein the computer-implemented programming additionally provides for acquisition and storage of at least one of a dark spectrum signal data and a background signal data seta; acquisition and storage of a measurement signal data set; and, subtraction of the background signal data set from the measurement signal data set to generate a background corrected measurement data set.

48. The photometric system of claim 47 wherein the computer-implemented programming additionally applies the calibration correction factors to the background corrected measurement data set to generate a calibrated measurement data set.

49. The photometric system of claim 48 wherein the computer-implemented programming additionally:

analyzes the calibrated measurement data set to determine if the calibrated measurement data set is of acceptable quality to provide an acceptable calibrated measurement data set and provides an indicator to the operator if the calibrated measurement data set is not of acceptable quality;

analyzes the acceptable calibrated measurement data set and provides an indication to a user of a performance characteristic for the photometric characteristics.

50. The photometric system of claim 49 wherein the computer-implemented programming additionally determines whether the performance characteristic is within an acceptable range.

51. The photometric system of claim 50 wherein the computer-implemented programming additionally records the performance characteristic in a computer-readable memory to provide a recorded measurement data set.

52. The photometric system of claim 51 wherein the computer-implemented programming additionally compares and analyzes at least one performance characteristic from a recorded measurement data set and at least one additional performance characteristic from a different time for at least one temporal trend.

53. The photometric system of claim 52 wherein the computer-implemented programming additionally provides an indicator of the temporal trend.

54. The photometric system of claim 45 or 46 wherein the computer-implemented programming additionally analyzes the data obtained from the photometric measurement module to determine if the data comprises an acceptable signal level and if not then adjusts data acquisition until the acceptable signal level is obtained.

55. The photometric system of claim 54 wherein the computer-implemented programming further provides an indicator to the operator if the acceptable signal level is not obtained.

56. The photometric system of claim 45 wherein the light collector is sized and shaped to transmit light from an endoscopic light source.

57. The photometric system of claim 56 wherein the system further comprises at least one adapter to transmit light from the sample light source through the endoscope upstream of the measurement integration sphere.

58. A test and measurement system able to assess performance characteristics of an endoscope comprising:

a photometric measurement module comprising at least one adapter able to optically connect the photometric measurement module to a plurality of different endoscopes, wherein the photometric measurement module measures at least one photometric performance characteristic selected from the group consisting of absolute optical intensity, relative optical intensity, optical power, optical energy, illuminance, radiance, irradiance, display color, perceived color and transmittance;

an image quality measurement module comprising at least one adapter able to optically connect the image quality measurement module to the plurality of different endoscopes, wherein the image quality measurement module measures at least one image quality performance characteristic selected from the group consisting of image size, spatial distortion, contrast, brightness, image resolution, focus and modulation transfer function;

a structural element measurement module comprising at least one adapter able to operably connect the structural element measurement module to the plurality of different endoscopes, wherein the structural element measurement module measures at least one structural element performance characteristic from at least one of a mechanical, a pneumatic and a fluidic system; and,

a controller containing computer-implemented programming that controls at least one of the calibration, measurement and analysis of the at least one photometric performance characteristic, the at least one image quality performance characteristic and the at least one structural element performance characteristic.